Lilies, Tilapia, and Gators – Oh My!

Idaho Puts Geothermal to Use for Greenhouse and Aquaculture Operations

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1. ABSTRACT

The existence of 544 wells and springs with water temperatures between 90 and 120 degrees Fahrenheit makes Idaho a great place for geothermal greenhouse and aquaculture businesses to set up shop. Currently, Idaho has 12 greenhouse operations that produce a wide variety of vegetables and flowers. Eleven aquaculture operations in Idaho are homes to catfish, tilapia, bullfrogs, ornamentals, and alligators that are raised with low temperature geothermal water. These geothermal greenhouse and aquaculture operations are found mostly throughout the southern part of the state.

Recently, there have been additional inquiries and interests with respect to a new greenhouse operation, an expansion of an existing greenhouse business, and a fresh water lobster farm downstream of a future geothermal electrical power plant. Clearly, Idaho is hot place for using geothermal water to produce vegetation and aquatic life.

2. PURPOSE AND OBJECTIVES

The purpose of this paper is to describe the history and projected future of using low temperature geothermal energy in Idaho for greenhouse and aquaculture operations. Three specific objectives are:

1. Illustrate how the use of geothermal to grow plants in Idaho began with a visionary in the 1920's and has progressed over the following decades so that Idaho is third in the nation with respect to the annual energy used and total area (Boyd and Lund, 2003).
2. Describe the vast diversity of aquatic life that is raised in Idaho using geothermal energy and includes edible fish, tropical fish, and alligators.
3. Discuss the areas in Idaho where new opportunities for these types of businesses might exist.

3. GEOTHERMAL MAKES THINGS GREEN

3.1. A Rich Green History

Thomas Edwards began a legacy in the summer of 1930 when he and a son started a truck farm in northwest Boise and began delivering vegetables to area grocery stores and door to door. The first crops were grown in a greenhouse that was heated by a geothermal well drilled in 1927 to a depth of 1,195 feet. In 1947, Thomas' son, Paul, assumed the helm of the business. Paul began growing cut flowers and other flowering crops, and was often recognized for bringing the first hybridized annuals to the Treasure Valley. In 1986, Paul retired, turning the business over to his daughter, Garnette. Currently, the Edwards Greenhouses operation covers approximately 90,000 square feet where production includes an amazing assortment of annuals, perennials, vegetables, seasonal potted crops, flowering shrubs and trees (Figure 1).

Figure 1. Annuals grown at Edwards Greenhouses.

Over the years, many names popped into the Idaho geothermal greenhouse scene such as Sligar, Flint, Archibald, Ward, Crook, Flora, Express, Bliss, Lost River, and others. Clearly, a market had been discovered! Some of these operations, such as Sligar, Ward, and Archibald have been in business for decades. Other places have come and gone, and still others have traded hands several times.

One of the operations that has seen a number of owners is the infamous 36th and State location in Boise just east of Edwards Greenhouses. This locale has been a geothermal greenhouse business for much of the last 60 years, but has had five different proprietors and several names. By the mid 1990's, the greenhouses became known as the Flora Company. The three wells at this location, and nine other wells in the general vicinity make up a regulatory entity called Ground Water District 63-S, which is the only geothermal ground water district in Idaho. In 2001, the majority of the water rights from Flora were transferred a couple miles northeast to the Terteling Ranch in order to help manage the delicate balance between withdrawals and water levels in this sensitive area. New greenhouses were constructed at the Terteling Ranch, and it is here that the Flora Company has continued its thriving operations.

Idaho entrepreneurs grow a wide variety of plants in 11 greenhouse operations heated by geothermal water (Table 1). Many growers focus on annuals that are delivered to wholesale markets. Perennials, potted plants and vegetable starts are popular retail plants. Some of the more unusual vegetation grown with geothermal in the past, or currently, includes mushrooms, lilies, and roses. The College of Southern Idaho in Twin Falls used geothermal water from their heating system to grow landscaping for the campus in the past (Figure 2), but the greenhouses are currently not operating.

New ideas are blooming in Idaho for putting geothermal to work in greenhouse operations. One visionary has a dream of growing reforestation seedlings in a geothermally-heated greenhouse. Wards Greenhouses has begun expanding its operations to Owyhee County, which is about 75 miles to the south of the current location. Another entrepreneur attempted to get a geothermal greenhouse business started in Idaho in 2003, but that effort appears to have stalled out.

Figure 2. Greenhouses at the College of Southern Idaho in Twin Falls have been used to grow plant to beautify the campus grounds.

3.2. Heating Systems in Greenhouse Operations

Heat is extracted from low temperature geothermal water for greenhouse operations through the use of heat exchangers, fan coil units, and radiant devices. Idaho geothermal greenhouses. Thus, the Idaho operations consist of: 1) production wells or springs which supply the water directly to a distribution system, 2) fan coil units that extract heat, and 3) radiant heat from pipes in the floors or in the benches. The most recent greenhouse technologies use sophisticated controls that open and close vents, and raise and lower sunscreens to optimize that temperature and humidity for the best production. However, it is not known whether any of the Idaho operations have installed this type of equipment.

Table 1. Geothermal greenhouse operations in Idaho.

County	Name	Supply Temperature (° Celsius)	Products	Acres	Estimated Energy Use (MWh/yr)[1]
Ada	Edwards Greenhouses	48	Annuals, perennials, vegetables	1.2	3,135
Ada	Flora Company	48	Bedding plants, annuals, perennials	2.0	?
Boise[3]	Wards Greenhouses	52	bedding plants and poinsettias	4.5	4,424[2]
Boise	Warm Springs Greenhouses, Inc.	76	Hanging baskets, potted azaleas	1.2	3,838
Butte	Lost River Geothermal Company	39	Lilies, cut flowers.	0.2	?
Fremont	Green Canyon Hot Springs	48	Tomatoes and cucumbers	0.2	615
Owyhee	Express Farms	47	Vegetables and bedding plants	1.3	234
Twin Falls	Canyon Bloomers	54	Bedding plants and flowers	2.3	4,747
Twin Falls	College of Southern Idaho	39	Flowers for the campus	<0.1	?
Twin Falls	Mountain States	46	Chrysanthemums, Cyclamen	3	5,831
Twin Falls	Thousands Springs Plants	74	Chrysanthemums, Klancheo	2.8	4,805[2]
TOTAL				18.7	27,629

[1] Source for this column is Lienau, 1997.

[2] This number is probably too low because new information indicates that more acres are under cover than reported by Lienau in 1997

[3] Wards has begun operation in Owyhee County, too.

Canyon Bloomers, located in Hagerman Valley and formerly known as M & L Greenhouses, has two geothermal production wells with total depths of 700 and 420 feet, and with water temperatures of 130° and 107° Fahrenheit (F), respectively. This greenhouse business has been in operation since 1970 and currently has 20 houses with a total coverage of 2.3 acres (Culver, 2004). In most of the greenhouses, water from the 130° F well passes through fan coil units, and then cascades into radiant floors. Three of

the greenhouses are serviced by the 107° F well, and they have radiant bench heating as well as radiant flooring. One greenhouse has only radiant floor heating.

Flora Company's new location has 12 greenhouses that cover almost two acres. The heating system for the buildings consists of 3/8 inch tubing run in the floor at three inches on center in 2/3 of the building, and ½ inch tubing run at six inch on center in the remainder of the buildings. Water supply temperature is about 118 degrees Fahrenheit. Plants are grown right on top of the floor. Flora has natural gas on location as a backup. The computerized heating system allows for automated control of vents and humidity in response to ambient conditions. Flora also boasts a unique watering system where a cable brings each hanging basket to a watering station. Flora sells bedding plants, perennials, potted plants, and aquatic plants on the wholesale market year round.

Wards Greenhouses in Garden Valley have been in operation since 1962 (Figure 3). Four geothermal springs supply water to 65 greenhouses that cover 4.5 acres. Geothermal water is supplied to the greenhouses at an average flow rate of 440 gallons per minute and with a temperature of 125 degrees Fahrenheit. Wards uses one inch PVC piping spaced 12 inched apart, and forced air heat exchangers to keep bedding plants and poinsettias thriving. The original ½ mile long trench for the supply line from the spring to the first greenhouse was hand dug by Jack Ward and his son Doug in 1964 at a rate of about 50 feet per day.

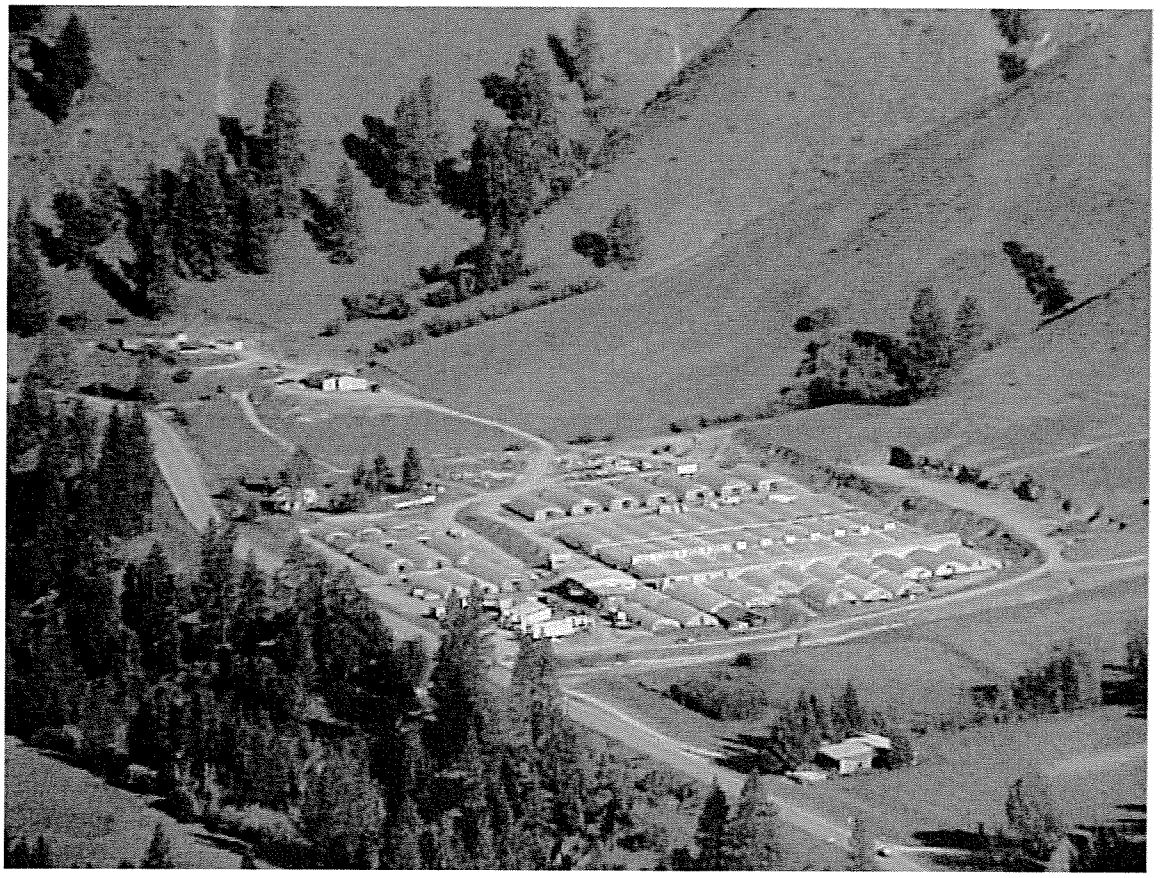

Figure 3. Wards Greenhouses in Garden Valley, Idaho (Photo Credit – Doug Ward).

4. AQUACULTURE THRIVES IN WARM WATER

From alligators to tilapia, geothermal water is put to use in Idaho for raising aquatic life forms (Table 2). Idaho geothermal industry ranks second behind California in heating capacity (Boyd and Lund, 2003). In 1973, Leo Ray became the first businessman in Idaho to utilize geothermal water for raising fish (U.S. Department of Energy, 2003). Over the years, Ray has drilled nine low temperature geothermal wells in the Hagerman Valley with water temperatures about 95 degrees Fahrenheit. The wells range in depth from about 500 to 1,100 feet. In addition to catfish, Mr. Ray currently uses the geothermal water to raise alligators (Figure 4). Some of Ray's gators have reached lengths of 14 feet and weigh 1000 pounds (Clutter, 2002). Ray's alligators serve multiple purposes including disposal for dead fish, hides for purses, boots and vests, and, of course, alligator meat is consumed by humans.

Table 2. Geothermal aquaculture operations in Idaho.

County	Name	Supply Temperature (° Celsius)	Product that Utilizes Geothermal	Acres
Ada	Geothermal Aquifer Research Foundation (GARF) www.garf.org/		Reefs and associated aquatic life	
Caribou	Smith Creek Hatchery		Tilapia, goldfish	
Custer	Epicenter Aquaculture	33	Tilapia	0.3
Jerome	Pristine Springs	43	Tilapia	1.4
Owyhee	Ace Development	38	Tilapia, ornamentals	0.3
Owyhee	Arraina, Inc.	38	Tilapia	0.3
Owyhee	Opaline AquaFarm, LLC	59	Tilapia, blue gill, koi, goldfish, grass carp, and aquatic plants	4.5
Twin Falls	Don Campbell	36	Tilapia, catfish	
Twin Falls	Canyon Springs Fish Farms	40	Tilapia, bullfrogs, ornamentals	
Twin Falls	Fish Breeders of Idaho	35	Catfish, tilapia, alligators	
Twin Falls	IdaSea	33	Ornamentals	

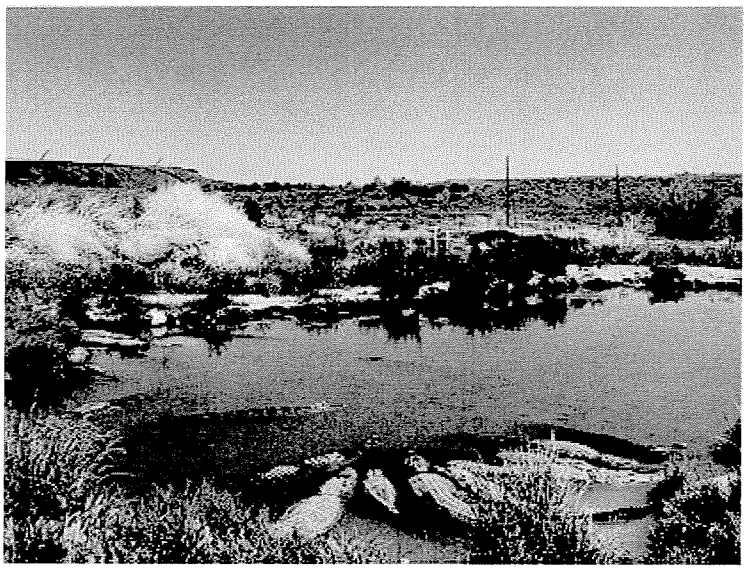

Figure 4. Alligators grown at the Fish Breeders of Idaho operation in south-central Idaho (Photo Credit – Bruce Green, USDOE).

Tilapia is a fairly new species to the United States fish market, but it is very important worldwide (Centers for Epidemiology and Animal Health, 1995). Production of tilapia has increased in the United States from 16 million in 1996 (Rafferty, 1999) to about 18 million pounds in 1999 (Johnson and Associates, 2000). In 2002, the value of imported tilapia increased 36% to $174 million (Collaborative Research Support Program, 2003). Tilapia is a mild tasting fish that reproduces prolifically and can tolerate crowded conditions and poor water quality (Centers for Epidemiology and Animal Health, 1995). With nine businesses identified, tilapia is the fish species that is most commonly raised in Idaho with geothermal water (Figure 5). Tilapia is also the third most commonly imported fish into the U.S., behind shrimp and Atlantic salmon (University of Tennessee Agricultural Extension Service, 1999).

The advantage of using geothermal water is that many species have accelerated growth rates in these temperatures (Witcher, 2002). New Mexico has a geothermal aquaculture business that raises tilapia using heat from a 400 foot well that is captured through the use of a heat exchanger (Witcher, 2002).

Currently, a study is being completed to evaluate the engineering needs and cost estimates for the Idaho Redclaw fresh water lobster raising business which has recently moved its operation to the the future Raft River geothermal power production site. A follow-up study will seek to determine the economic feasibility of this operation.

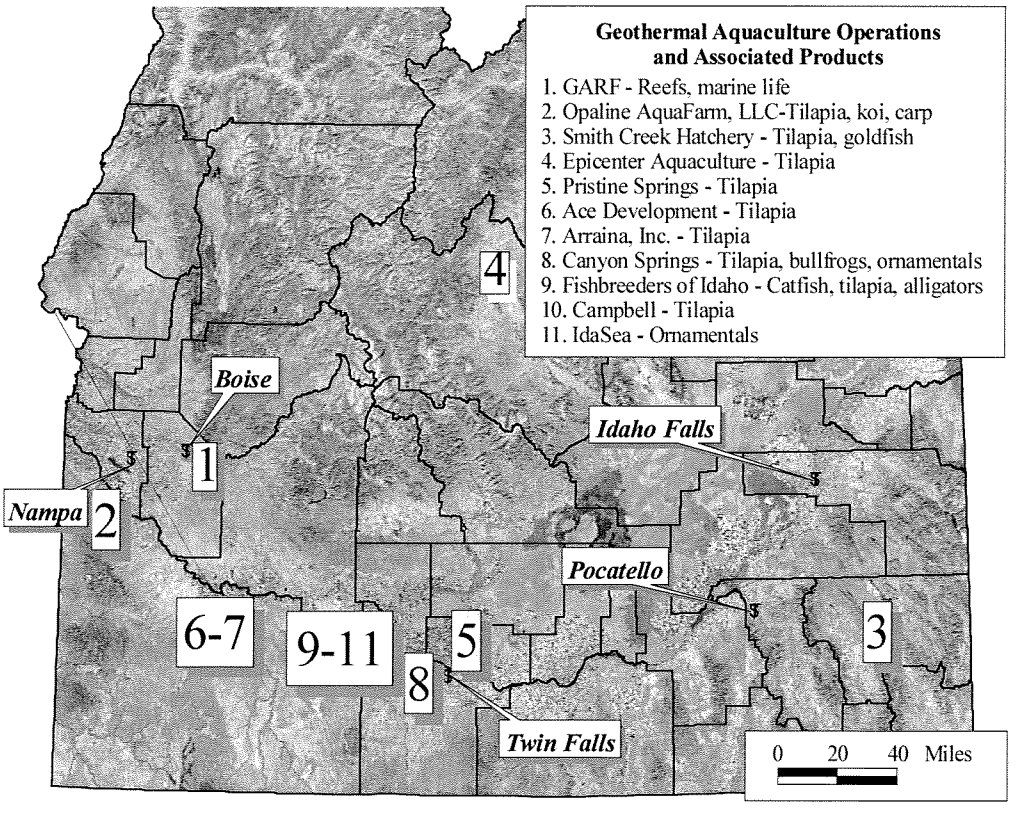

Figure 5. Geothermal aquaculture operations in Idaho.

Another unique and unusual aquaculture operations in Idaho is the Geothermal Aquaculture Research Foundation (GARF), which is located in Boise. GARF's mission is to provide "a showcase collection of aquatic plants, fish, reef animals and products, and to stimulate an interest in, and an appreciation of, these collections" (GARF website http://www.garf.org/). The GARF facility is located in a home along Warm Springs Avenue. The geothermal water is actually the discharged fluids from homes that are on the Boise Warm Springs Water District distribution system. Hundreds of plant and animal species live in the micro environment that goes unnoticed to most of the citizens of Boise (Figure 6).

Figure 6. Corals and other marine life thrive at the Geothermal Aquaculture Research Foundation in Boise (Photo credit: GARF).

5. THE FUTURE OF GEOTHERMAL GREENHOUSES AND AQUACULTURE IN IDAHO

Based on past success, Idaho faces a bright future for additional greenhouse and aquaculture operations that use low temperature geothermal water. New developments and expansions of greenhouse and aquaculture operations would contribute to the local economic vitalities in Idaho. The use of geothermal energy for these businesses will also reduce reliance on fossil fuels.

However, the decline of water levels in the southern part of the state create a major barrier because some areas are closed to new applications for water diversions. The initial cost of a new operation is also a very large hurdle for Idaho entrepreneurs. Partnerships between Federal, State and private entities, and creative ideas such as cascading applications at geothermal sources may be the answers to helping businesses get started with their geothermal developments.

An Idaho Geothermal Energy Working Group was formed in 2001 to help facilitate continued development of geothermal energy resources in Idaho for various applications

including greenhouse and aquaculture operations. The group produced the Idaho Geothermal Energy Development Strategic Plan, which identified key objectives to pursue (IDWR, 2002).

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